

Detection of fissile material hidden in a legal shipment of a radioactive source



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Radioactive sources are employed in industry and medicine

Radioactive sources are legally shipped every day

Reduced detection/discrimination capability exposes to the possibility to hide fissile material in a legal transport

Exercise: investigate the possibility to detect plutonium hidden within a transport of a legal radioactive source

Weapon grade plutonium is constituted by Pu-239 > 90%

Use NUCLEONICA to derive the main radiation properties of Pu-239

Half-life

Specific activity

Neutron production

Gamma production

Weapon grade plutonium is constituted by Pu-239 > 90%

Use NUCLEONICA to derive the main radiation properties of Pu-239

Half-life	24114 years		
Specific activity	2.29E+9 Bq/g		
Neutron production	1.65E-02 n/s/g		
Gamma production	12.963	0.000341	(too low energy)
	51.624	0.00027	(too low energy)
	38.66	0.0001037	(too low energy)
	129.297	6.35E-05	(easily shielded)
	375.05	1.556E-05	++
	413.71	1.472E-05	++

Use the gamma spectrum generator to see:

- An ideal spectrum from unshielded Pu-239 using a coaxial HPGe**
- An ideal spectrum from unshielded Pu-239 using a 3"x3" NaI**
- A spectrum from Pu-239 shielded with 5 cm lead**
- A spectrum from Pu-239 shielded with 20 cm lead**

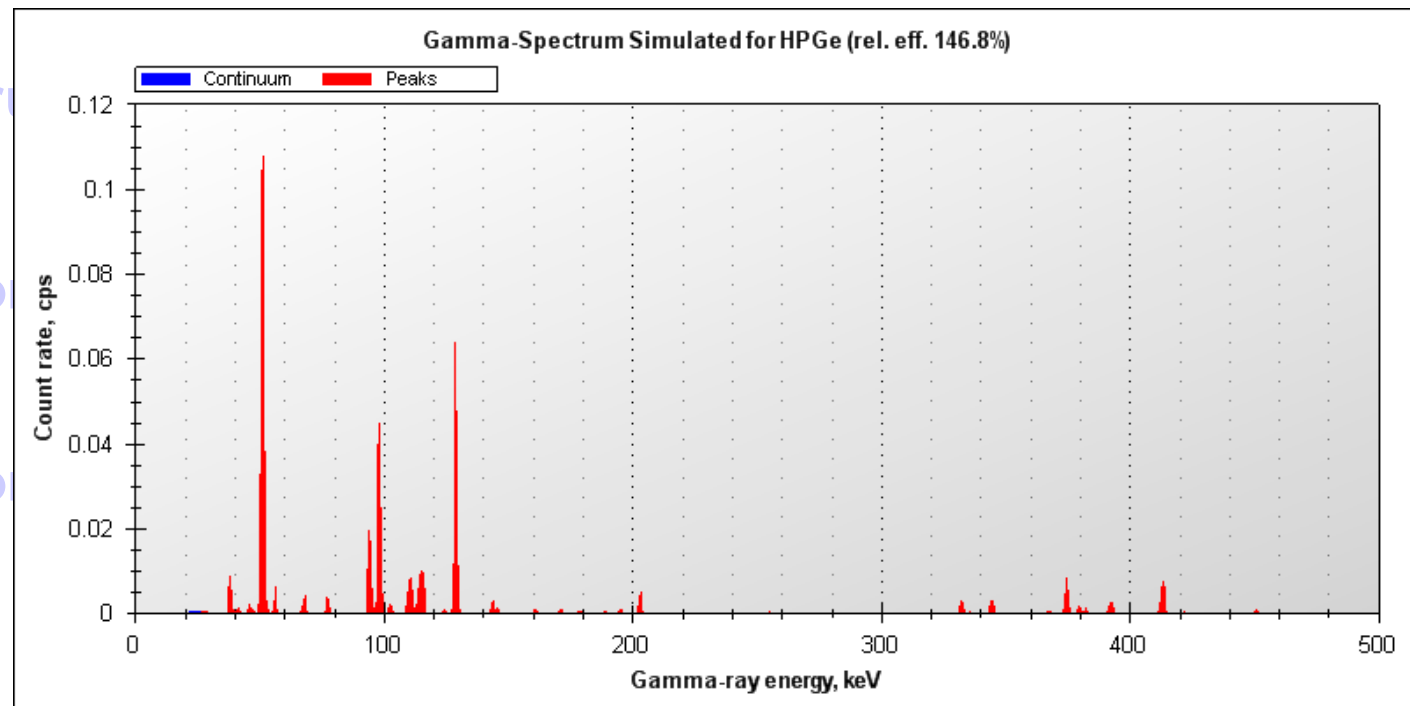
Use the gamma spectrum generator to see:

- An ideal spectrum from unshielded Pu-239 using a coaxial HPGe

- An ideal spectrum

- A spectrum from

- A spectrum from



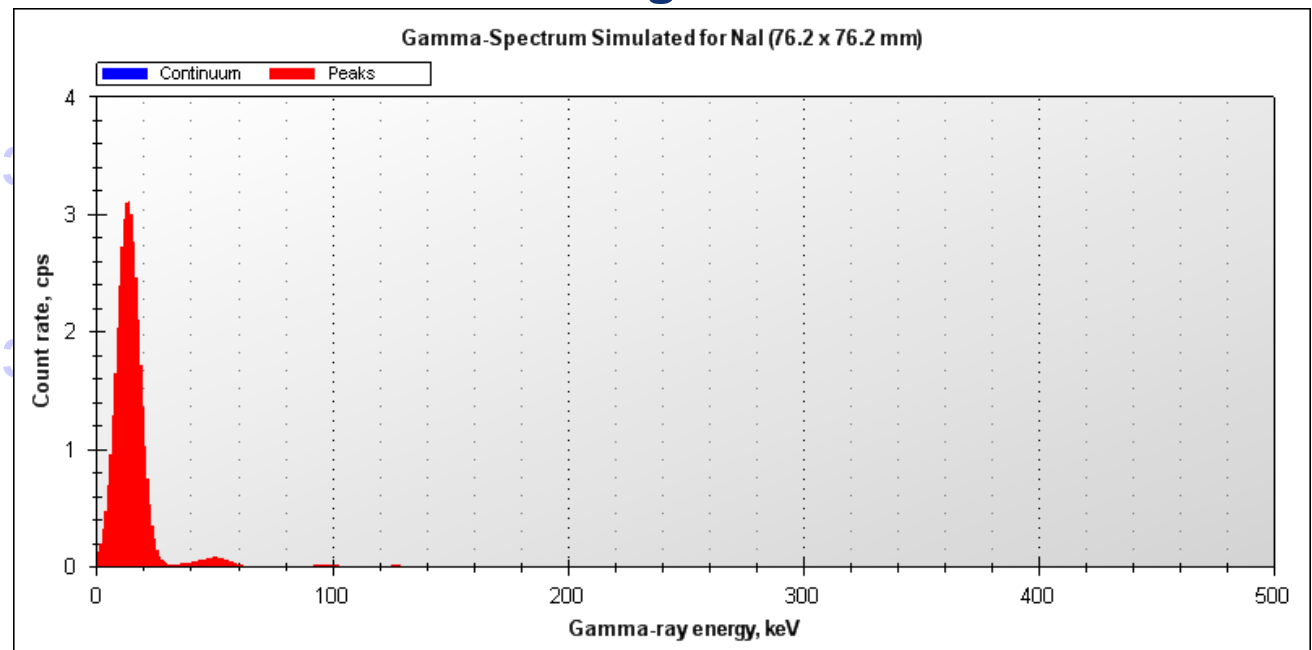
Use the gamma spectrum generator to see:

- An ideal spectrum from unshielded Pu-239 using a coaxial HPGe

- An ideal spectrum from unshielded Pu-239 using a 3"x3" NaI

- A spectrum from Pu-239

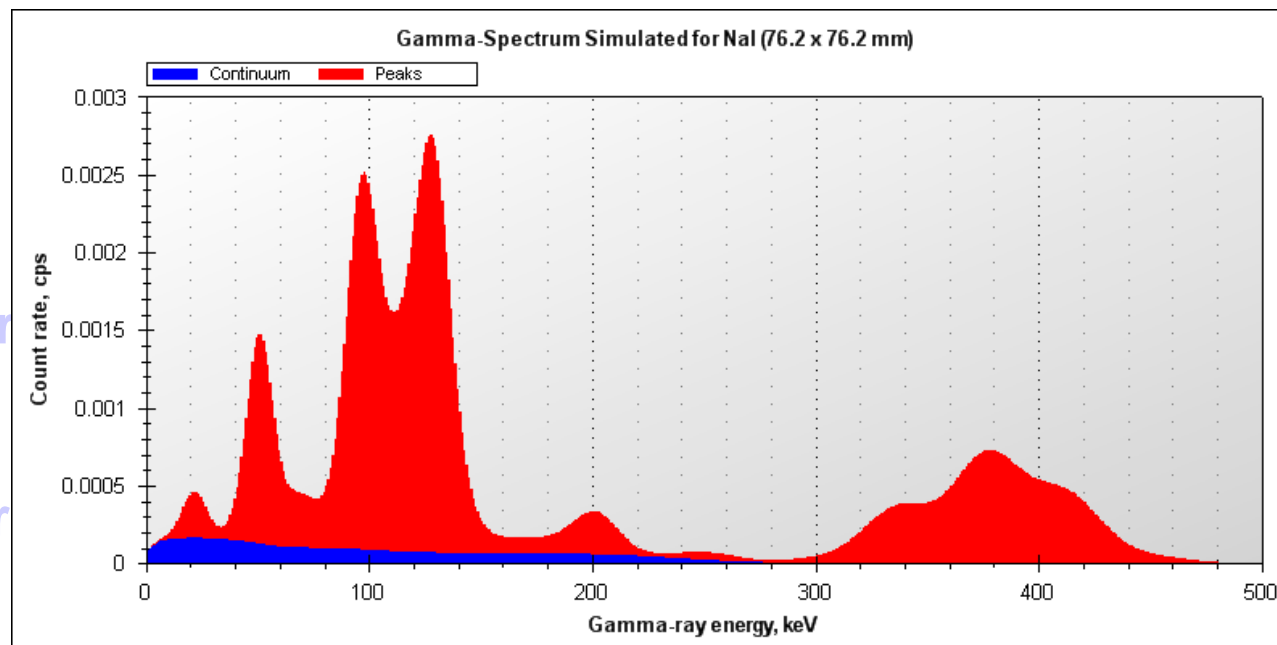
- A spectrum from Pu-239



Use the gamma

- An ideal spectr

- An ideal spectr



- A spectrum from Pu-239 shielded with 5 cm lead

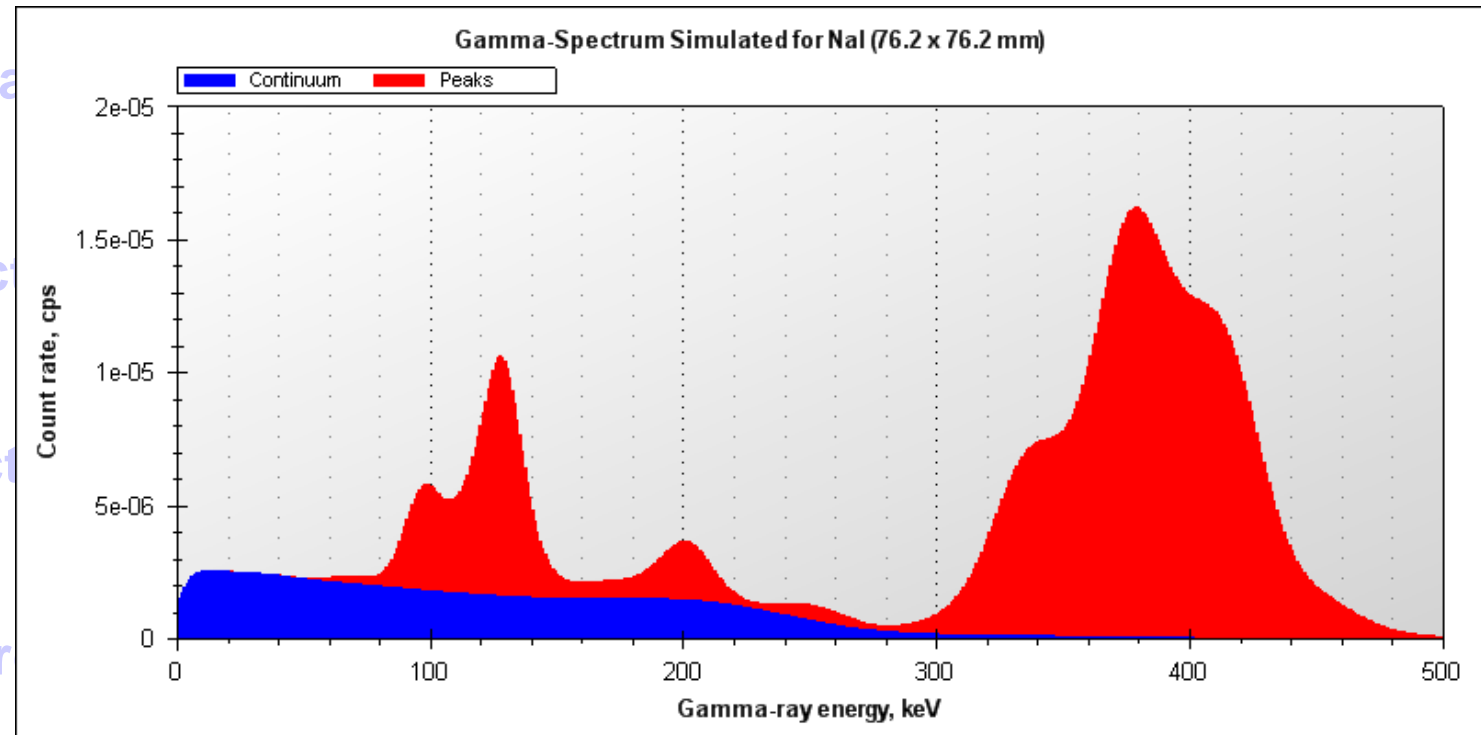
- A spectrum from Pu-239 shielded with 20 cm lead

Use the gamma

- An ideal spect

- An ideal spect

- A spectrum fr



- A spectrum from Pu-239 shielded with 20 cm lead

Ba-133 is used for mainly for laboratory (calibration of gamma spectrometers) and industrial applications (density gauges and thickness gauges)

Use NUCLEONICA to derive the main properties of Ba-133

Half-life

Specific activity

Gamma production

Ba-133 is used for mainly for laboratory (calibration of gamma spectrometers) and industrial applications (density gauges and thickness gauges)

Use NUCLEONICA to derive the main properties of Ba-133

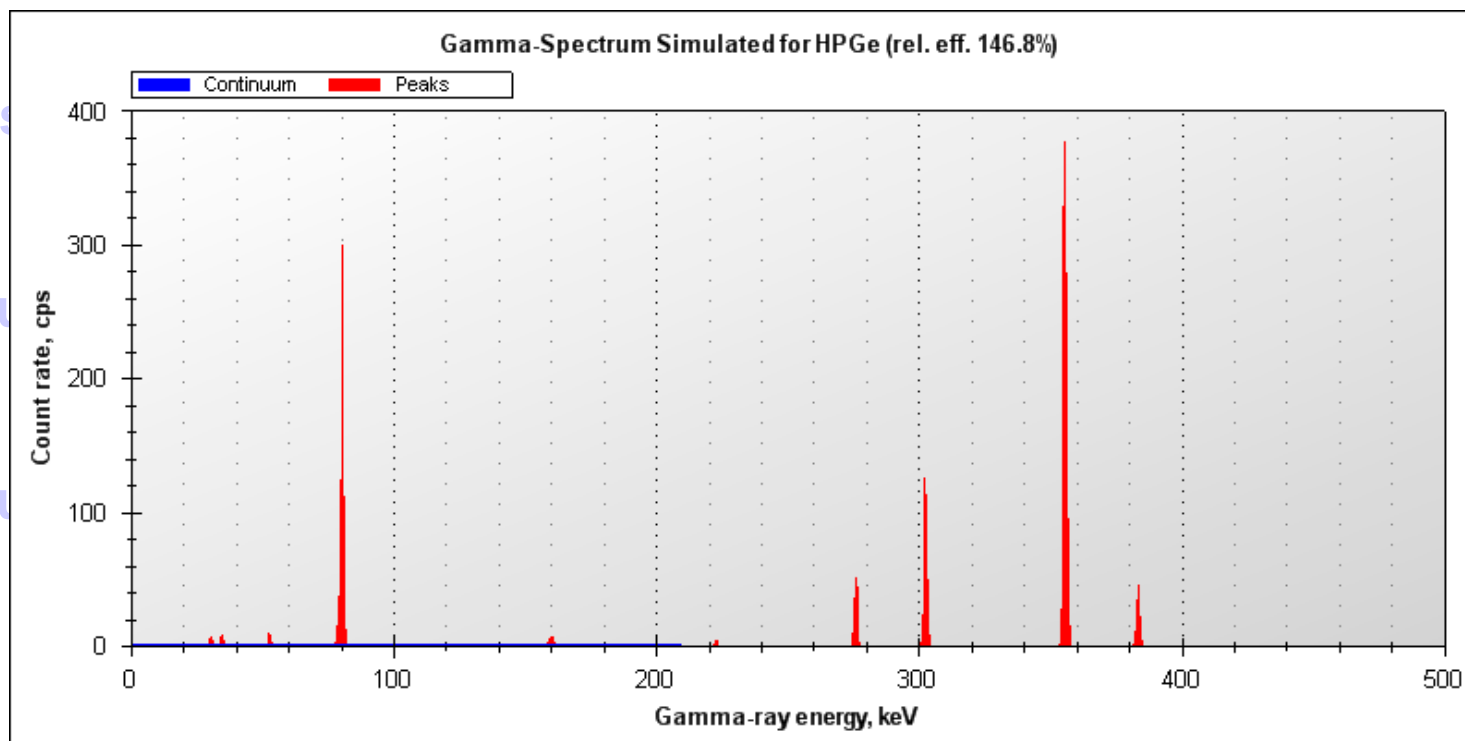
Half-life	10.54 years		
Specific activity	9.44E+12 Bq/g		
Gamma production	356.013	0.6205	(ideal to mask Pu-239)
	80.9979	0.329	
	302.85	0.1834	
	383.849	0.0894	(ideal to mask Pu-239)
	276.399	0.0716	

Use the gamma spectrum generator to see:

- An ideal spectrum from unshielded Ba-133 using a coaxial HPGe**
- An ideal spectrum from unshielded Ba-133 using a 3"x3" NaI**
- A spectrum from Ba-133 shielded with 5 cm lead**
- A spectrum from Ba-133 shielded with 20 cm lead**

Use the gamma spectrum generator to see:

- An ideal spectrum from unshielded Ba-133 using a coaxial HPGe

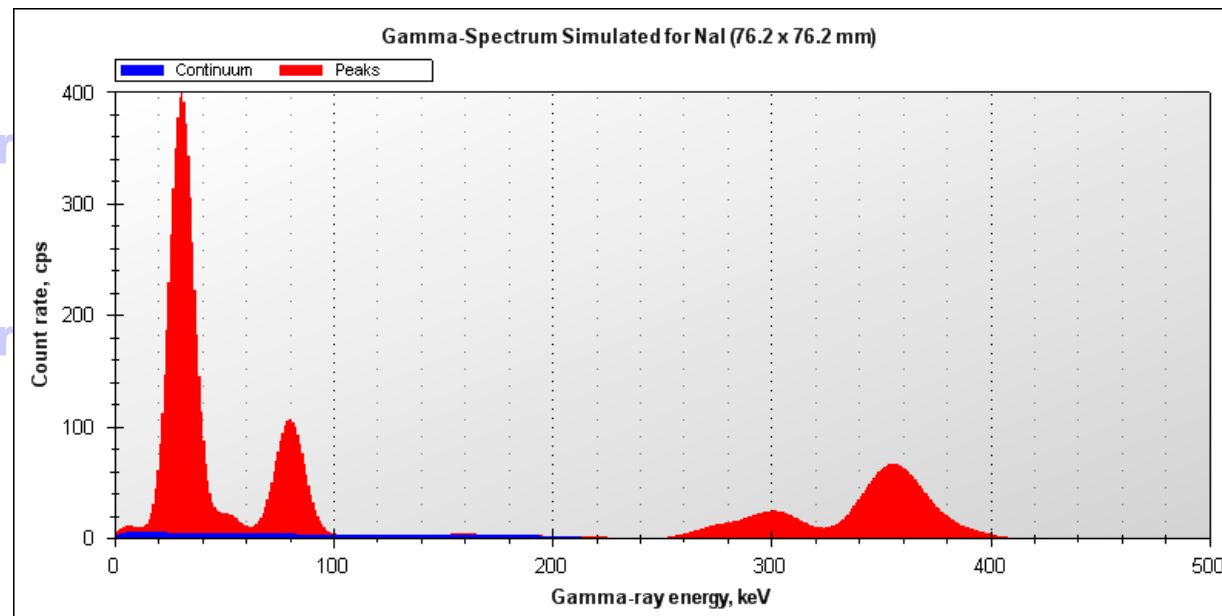


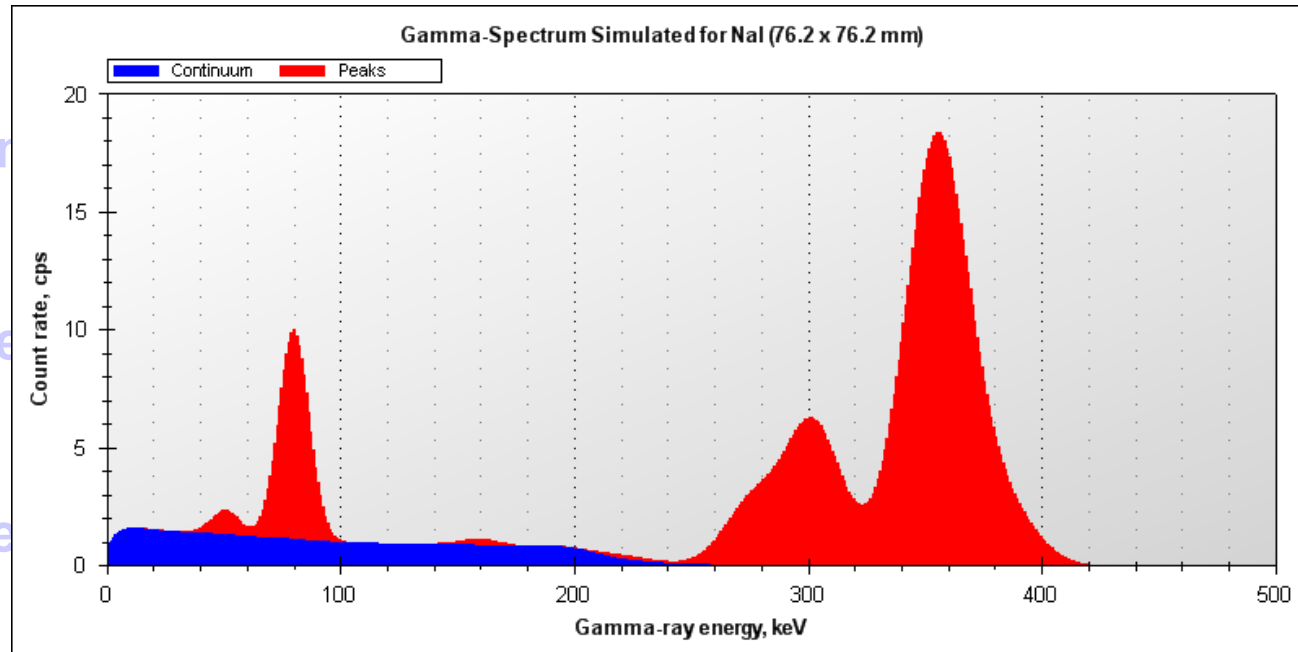
Use the gamma spectrum generator to see:

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- An ideal spectrum from unshielded Ba-133 using a 3"x3" NaI

- A spectrum fr

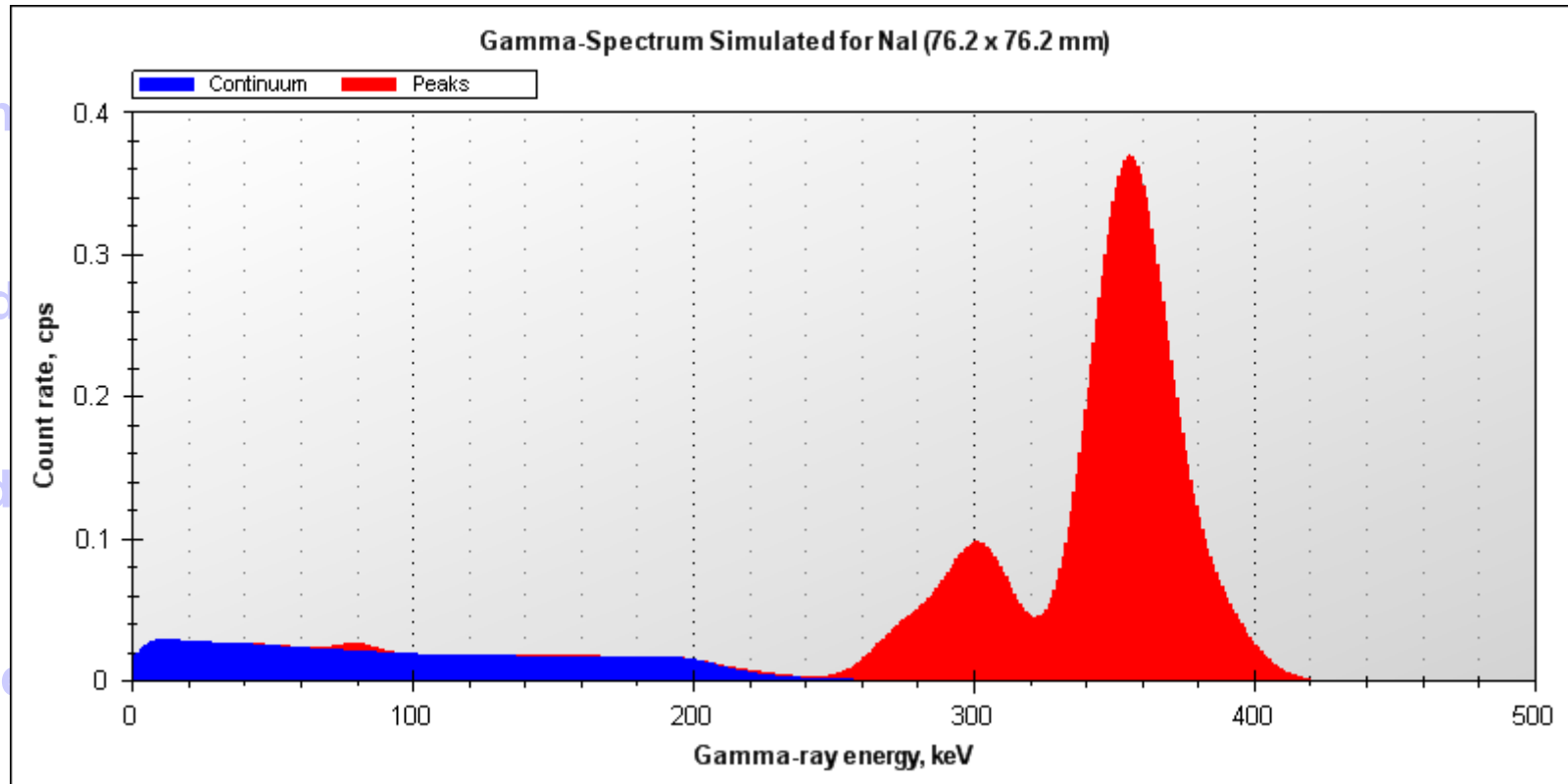
- A spectrum fr





- A spectrum from Ba-133 shielded with 5 cm lead

- A spectrum from Ba-133 shielded with 20 cm lead



- A spectrum from Ba-133 shielded with 20 cm lead

Use NUCLEONICA to generate a mixture of:

Ba-133 3 mCi

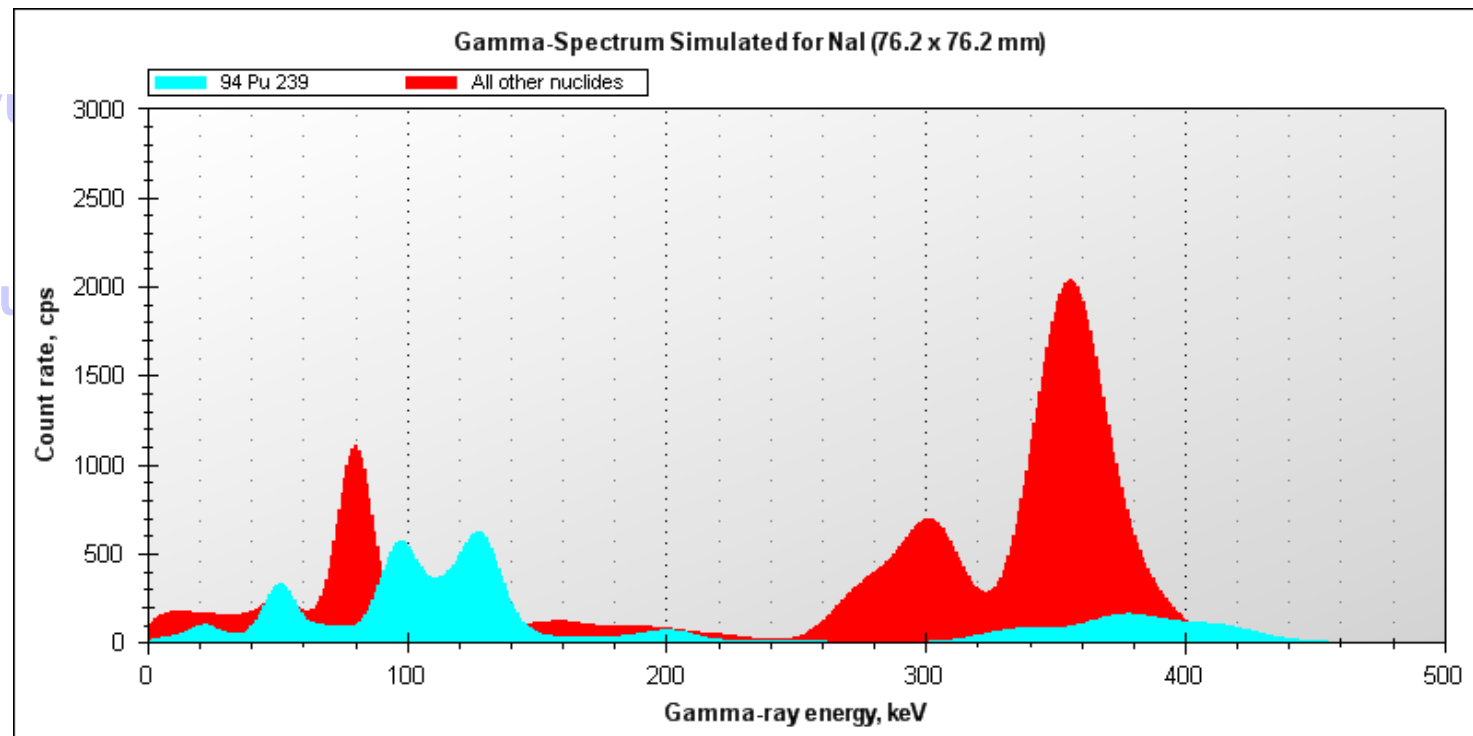
Pu-239 100 g

Use the gamma spectrum generator to see:

- A spectrum from the mixture shielded with 5 cm lead using NaI**
- A spectrum from the mixture shielded with 20 cm lead using NaI**
- A spectrum from the mixture shielded with 20 cm lead using HPGe**

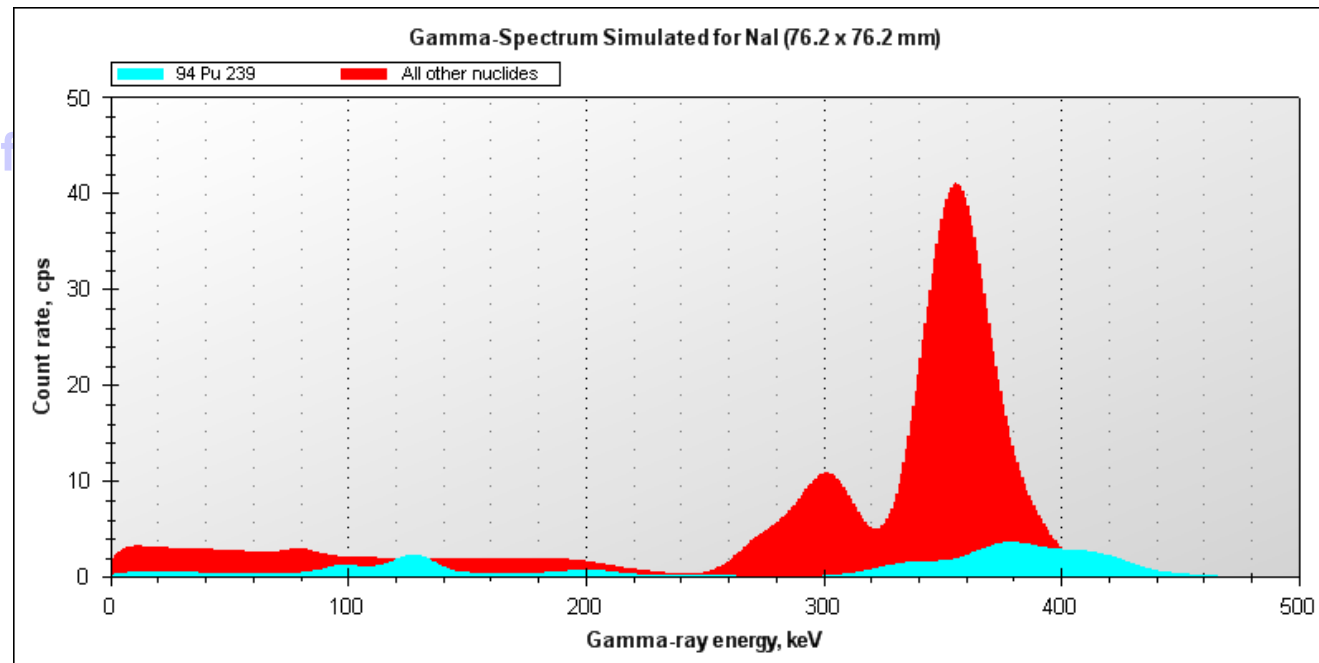
Use the gamma spectrum generator to see:

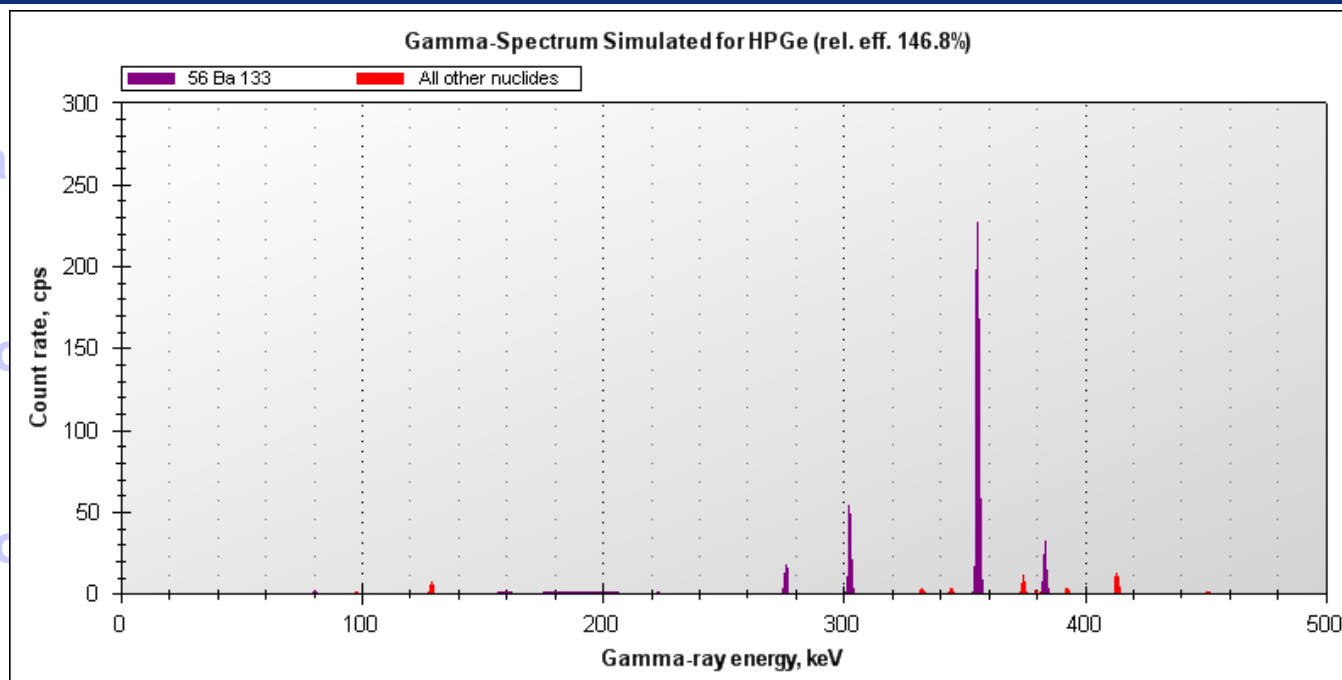
- A spectrum from the mixture shielded with 5 cm lead using NaI



Use the gamma spectrum generator to see:

- A spectrum from the mixture shielded with 5 cm lead using NaI
- A spectrum from the mixture shielded with 20 cm lead using NaI





Use the gamma

- A spectrum from

- A spectrum from

- A spectrum from the mixture shielded with 20 cm lead using HPGe

High resolution allows the detection of masked isotopes

Weapon grade plutonium contains also Pu-240

Use NUCLEONICA to compute the neutron emission from 100 g of plutonium with the following isotopic composition:

95% Pu-239

5% Pu-240

Weapon grade plutonium contains also Pu-240

Use NUCLEONICA to compute the neutron emission from 100 g of plutonium with the following isotopic composition:

95% Pu-239 $95 * 1.65E-02 = 1.6$

5% Pu-240 $5 * 1029 = 5145$

>5000 n/s : Neutrons are easily detected (zero background)

Thank you !

**For further information or questions
please contact me**

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